CLAIMS

I CLAIM:

1. A V-twin reciprocating apparatus having a crankshaft mounted in a crankcase for rotation about a crankshaft axis, the V-twin reciprocating apparatus comprising:

a pair of cylinders, each defining a cylinder axis orthogonally disposed with respect to the crankshaft axis, the cylinders disposed in a V configuration with respect to one another, with the cylinder axes defining an included angle with respect to one another bisected by a central plane including the crankshaft axis;

a pair of pistons disposed, one in each cylinder, for reciprocating movement in the cylinders along the cylinder axes from a top dead center (TDC) position to a bottom dead center (BDC) position in the cylinders; and

a pair of connecting rods, one in each cylinder, for operatively connecting the pistons to the crankshaft such that the pistons will reach TDC and BDC in their respective cylinders at substantially the same time;

the connecting rods joined at a crankshaft end thereof to the crankshaft by a pair of connecting rod journals centered at a common throw radius from the crankshaft axis and angularly displaced from one another along the throw radius by an angular displacement equal to the included angle of the cylinder axes.

2. The V-twin reciprocating apparatus of claim 1, wherein the apparatus is an engine with the pair of cylinders firing alternately on sequential rotations of the crankshaft when the piston in the firing cylinder is approximately at TDC.

3. The V-twin reciprocating apparatus of claim 1, wherein the crankshaft further includes a counterweight fixedly attached thereto at a point substantially diametrically opposite the pistons for rotation with the crankshaft about the crankshaft, to thereby substantially center the counterweight along the central plane at a point opposite the pistons when the pistons are at TDC, and along the central plane at a point adjacent the pistons when the pistons are at BDC.

4. The V-twin reciprocating apparatus of claim 3, wherein the crankshaft defines a direction of rotation of the crankshaft, and the V-twin reciprocating apparatus further includes a first balance shaft operatively connected to the crankshaft for rotation about a first balance shaft axis in a direction opposite the direction of rotation of the crankshaft.

5. The V-twin reciprocating apparatus of claim 4, wherein the first balance shaft rotates about the first balance shaft axis in a one-to-one (1:1) ratio of rotations of the first balance shaft with respect to rotations of the crankshaft.

6. The V-twin reciprocating apparatus of claim 5, wherein:

the first balance shaft axis is oriented in a direction parallel to the crankshaft axis and lying in a first balance shaft plane extending parallel to the central plane; and

the first balance shaft further comprises a first balance shaft counterweight attached thereto for rotation with the first balance shaft about the first balance shaft axis from a first position at a point substantially opposite the cylinders along the first balance shaft plane when the pistons are at TDC, to a second point substantially adjacent the cylinders along the first balance shaft plane when the pistons are at BDC.

7. The V-twin reciprocating apparatus of claim 6, wherein the first balance shaft axis and the crankshaft axis lie in a common transverse plane orthogonally intersecting the central plane.

8. The V-twin reciprocating apparatus of claim 7 further comprising:

a second balance shaft operatively connected to the crankshaft for rotation about a second balance shaft axis in unison with the first balance shaft in a direction opposite the direction of rotation of the crankshaft in a one-to-one (1:1) ratio of rotations of the second balance shaft with respect to rotations of the crankshaft;

the second balance shaft axis is oriented in a direction parallel to the crankshaft axis in the common transverse plane and lying in a second balance shaft plane extending parallel to the central plane;

the second balance shaft further comprising a second balance shaft counterweight attached thereto for rotation with the second balance shaft about the second balance shaft axis, in unison with the counterweight of the first balance shaft, from a first position of at a point substantially opposite the cylinders along the second balance shaft plane when the pistons are at TDC, to a second point substantially adjacent the cylinders along the second balance shaft plane when the pistons are at BDC.

9. The V-twin reciprocating apparatus of claim 8, wherein the counterweight on the crankshaft is sized for counterbalancing one half of a total unbalance load of the reciprocating apparatus, and the counterweights on the first and second balance shafts are each sized for counterbalancing one quarter of the total unbalance load of the reciprocating apparatus.

10. The V-twin reciprocating apparatus of claim 9, wherein the V-twin reciprocating apparatus is an engine with the pair of cylinders firing alternately on sequential rotations of the crankshaft when the piston in the firing cylinder is approximately at TDC.

11. A V-twin engine comprising:

a crankshaft mounted in an engine block for rotation about a crankshaft axis;

a pair of cylinders, each defining a cylinder axis orthogonally disposed with respect to the crankshaft axis, the cylinders disposed in a V configuration with respect to one another, with the cylinder axes defining an included angle with respect to one another bisected by a central plane including the crankshaft axis;

a pair of pistons disposed, one in each cylinder, for reciprocating movement in the cylinders along the cylinder axes from a top dead center (TDC) position to a bottom dead center (BDC) position in the cylinders;

a pair of connecting rods, one in each cylinder, for operatively connecting the pistons to the crankshaft such that the pistons will reach TDC and BDC in their respective cylinders at substantially the same time;

the connecting rods joined at a crankshaft end thereof to the crankshaft by a pair of connecting rod journals centered at a common throw radius from the crankshaft axis and angularly displaced from one another along the throw radius by an angular displacement equal to the included angle of the cylinder axes; and

one or more counterweights operatively connected to the crankshaft for counterbalancing an unbalance load of the engine.

12. The V-twin engine of claim 11, wherein the engine is a four-stroke engine.

13. The V-twin engine of claim 12 wherein the pair of cylinders fire alternately on sequential rotations of the crankshaft when the piston in the firing cylinder is approximately at TDC.

14. The V-twin engine of claim 12 further comprising:

a crankshaft counterweight attached to the crankshaft for rotation therewith about the crankshaft axis; and

a first balance shaft having a counterweight attached thereto, mounted within the engine block for rotation about a first balance shaft axis, and operatively connected to the crankshaft to be rotated thereby about the first balance shaft axis.

15. The V-twin engine of claim 14 wherein the first balance shaft rotates in a direction opposite a direction of rotation of the crankshaft in a one-to-one (1:1) ratio of rotations of the second balance shaft with respect to rotations of the crankshaft.

16. The V-twin engine of claim 15, further comprising:

a second balance shaft operatively connected to the crankshaft for rotation about a second balance shaft axis in unison with the first balance shaft in a direction opposite the direction of rotation of the crankshaft in a one-to-one (1:1) ratio of rotations

of the second balance shaft with respect to rotations of the crankshaft;

the second balance shaft further comprising a second balance shaft counterweight attached thereto for rotation with the second balance shaft about the second balance shaft axis, in unison with the counterweight of the first balance shaft.

17. The V-twin reciprocating engine of claim 16, wherein the unbalance load is a total unbalance load of the engine, the crankshaft counterweight is sized for counterbalancing one half of the total unbalance load of the engine, and the counterweights on the first and second balance shafts are each sized for counterbalancing one quarter of the total unbalance load of the engine.

18. A method for operating a V-twin engine, having a crankshaft mounted in an engine block for rotation about a crankshaft axis, a pair of cylinders, each defining a cylinder axis orthogonally disposed with respect to the crankshaft axis, the cylinders disposed in a V configuration with respect to one another, with the cylinder axes defining an included angle with respect to one another bisected by a central plane including the crankshaft axis, a pair of pistons disposed, one in each cylinder, for reciprocating movement in the cylinders along the cylinder axes from a top dead center (TDC) position to a bottom dead center (BDC) position in the cylinders, and a pair of connecting rods, one in each cylinder, the method comprising:

connecting the pistons to the crankshaft with the connecting rods, by joining the connecting rods at a crankshaft end thereof to the crankshaft by a pair of connecting rod journals centered at a common throw radius from the crankshaft axis and angularly displaced from one another along the throw radius by an angular displacement equal to the included angle of the cylinder axes, so that the pistons will each reach TDC in their respective cylinders at substantially the same time and BDC in their respective cylinders at substantially the same time.

19. The method of claim 18, further comprising, controlling ignition in the engine in such a manner that the cylinders fire alternately on sequential rotations of the crankshaft when the piston in the firing cylinder is approximately at TDC.

20. The method of claim 13, wherein the engine defines a total unbalance load of the engine, and the method further comprises:

attaching a crankshaft counterweight to the crankshaft for rotation therewith about the crankshaft axis; and

providing a first balance shaft having a counterweight attached thereto, mounted within the engine block for rotation about a first balance shaft axis, and operatively connected to the crankshaft to be rotated thereby about the first balance shaft axis in a direction opposite a direction of rotation of the crankshaft in a one-to-one (1:1) ratio of rotations of the second balance shaft with respect to rotations of the crankshaft.

21. The method of claim 20, further comprising:

providing a second balance shaft operatively connected to the crankshaft for rotation about a second balance shaft axis in unison with the first balance shaft in a direction opposite the direction of rotation of the crankshaft in a one-to-one (1:1) ratio of rotations of the second balance shaft with respect to rotations of the crankshaft;

the second balance shaft further comprising a second balance shaft counterweight attached thereto for rotation with the second balance shaft about the second balance shaft axis, in unison with the counterweight of the first balance shaft.

22. The method of claim 21, wherein the engine defines a total unbalance load of the engine, and the method further comprises:

counterbalancing one half of the total unbalance load of the engine with the crankshaft counterweight;

counterbalancing one quarter of the total unbalance load of the engine with the counterweight on the first balance shaft; and

counterbalancing one quarter of the total unbalance load of the engine with the counterweight on the second balance shaft.